needs no leading in this matter, though it certainly does need encouragement to take under its wing a science museum and laboratory. This then it seems to us ought to be the first care of the Commissioners, leaving the examination rooms out of the reckoning, while the library can easily afford to wait for future consideration. If the idea of a library is brought too prominently to the front, we fear the building will come to be known by this and no other name, and come in the end to be mainly, if not only, what its name purports. We believe the Commissioners could spare 100,000*l.* for a Science Museum; and we are sure the great success which has attended the Loan Collection will tend to confirm them in their intentions, and induce them without delay to set about providing a permanent successor. We have no doubt that the Commissioners are quite alive to the value of a Physical Science Museum and Laboratory, and feel strongly the great need there is in this country for such an institution. They have on the whole done their work conscientiously and well, and South Kensington testifies to the highly important and beneficial results which they have accomplished. By erecting an institution for the promotion of physical science, they will show their anxiety to make their work complete in all the departments with which they have had to deal. Twenty years ago they started the Museum of Art at Kensington; if twenty years hence a Museum of Science has made equal progress, the nation will have reason to congratulate itself on the result, and be grateful to the Commissioners for the faithfulness with which they have done their work.

WHEWELL'S WRITINGS AND CORRESPONDENCE

William Whewell, D.D., Master of Trinity College, Cambridge. An Account of his Writings, with Selections from his Literary and Scientific Correspondence. By I. Todhunter, M.A., F.R.S., Honorary Fellow of St. John's College. (London: Macmillan and Co., 1876.)

WE frequently hear the complaint that as the boundaries of science are widened its cultivators become less of philosophers and more of specialists, each confining himself with increasing exclusiveness to the area with which he is familiar. This is probably an inevitable result of the development of science, which has made it impossible for any one man to acquire a thorough knowledge of the whole, while each of its sub-divisions is now large enough to afford occupation for the useful work of a lifetime. The ablest cultivators of science are agreed that the student, in order to make the most of his powers, should ascertain in what field of science these powers are most available, and that he should then confine his investigations to this field, making use of other parts of science only in so far as they bear upon his special subject.

Accordingly we find that Dr. Whewell, in his article in the "Encyclopædia Metropolitana," on "Archimedes and Greek Mathematics," says of Eratosthenes, who, like himself, was philologer, geometer, astronomer, poet, and antiquary: "It is seldom that one person attempts to master so many subjects without incurring the charge and perhaps the danger of being superficial."

It is probably on account of the number and diversity of the kinds of intellectual work in which Dr. Whewell attained eminence that his name is most widely known. Of his actual performances the "History" and the "Philosophy of the Inductive Sciences" are the most characteristic, and this because his practical acquaintance with a certain part of his great subject enabled him the better to deal with those parts which he had studied only in books, and to describe their relations in a more intelligent manner than those authors who have devoted themselves entirely to the general aspect of human knowledge without being actual workers in any particular department of it.

But the chief characteristic of Dr. Whewell's intellectual life seems to have been the energy and perseverance with which he pursued the development of each of the great ideas which had in the course of his life presented itself to him. Of these ideas some might be greater than others, but all were large.

The special pursuit, therefore, to which he devoted himself was the elaboration and the expression of the ideas appropriate to different branches of knowledge. The discovery of a new fact, the invention of a theory, the solution of a problem, the filling up of a gap in an existing science, were interesting to him not so much for their own sake as additions to the general stock of knowledge, as for their illustrative value as characteristic instances of the processes by which all human knowledge is developed.

To watch the first germ of an appropriate idea as it was developed either in his own mind or in the writings of the founders of the sciences, to frame appropriate and scientific words in which the idea might be expressed, and then to construct a treatise in which the idea should be largely developed and the appropriate words copiously exemplified—such seems to have been the natural channel of his intellectual activity in whatever direction it overflowed. When any of his great works had reached this stage he prepared himself for some other labour, and if new editions of his work were called for, the alterations which he introduced often rather tended to destroy than to complete the unity of the original plan.

Mr. Todhunter has given us an exhaustive account of Dr. Whewell's writings and scientific work, and in this we may easily trace the leading ideas which he successively inculcated as a writer. We can only share Mr. Todhunter's regret that it is only as a writer that he appears in this book, and it is to be hoped that the promised account of his complete life as a man may enable us to form a fuller conception of the individuality and unity of his character, which it is hard to gather from the multifarious collection of his books.

Dr. Whewell first appears before us as the author of a long series of text-books on Mechanics. His position as a tutor of his College, and the interest which he took in University education, may have induced him to spend more time in the composition of elementary treatises than would otherwise have been congenial to him, but in the prefaces to the different editions, as well as in the introductory chapters of each treatise, he shows that sense of the intellectual and educational value of the study of first principles which distinguishes all his writings. It is manifest from his other writings, that the composition of these text-books, involving as it did a thorough study of the fundamental science of Dynamics, was a most appro-

priate training for his subsequent labours in the survey of the sciences in their widest extent.

"It has always appeared to me," says Mr. Todhunter, "that Mr. Whewell would have been of great benefit to students if he had undertaken a critical revision of the technical language of Mechanics. This language was formed to a great extent by the early writers at an epoch when the subject was imperfectly understood, and many terms were used without well-defined meanings. Gradually the language has been improved, but it is still open to objection."

In after years, when his authority in scientific terminology was widely recognised, we find Faraday, Lyell, and others applying to him for appropriate expressions for the subject-matter of their discoveries, and receiving in reply systems of scientific terms which have not only held their place in technical treatises, but are gradually becoming familiar to the ordinary reader.

"Is it not true," Dr. Whewell asks in his Address to the Geological Society, "in our science as in all others, that a technical phraseology is real wealth, because it puts in our hands a vast treasure of foregone generalisations?"

Perhaps, however, he felt it less difficult to induce scientific men to adopt a new term for a new idea than to persuade the students and teachers of a University to alter the phraseology of a time-honoured study.

But even in the elementary treatment of Dynamics, if we compare the text-books of different dates, we cannot fail to recognise a marked progress. Those by Dr. Whewell were far in advance of any former text-books as regards logical coherence and scientific accuracy, and if many of those which have been published since have fallen behind in these respects, most of them have introduced some slight improvement in terminology which has not been allowed to be lost.

Dr. Whewell's opinion with respect to the evidence of the fundamental doctrines of mechanics is repeatedly inculcated in his writings. He considered that experiment was necessary in order to suggest these truths to the mind, but that the doctrine when once fairly set before the mind is apprehended by it as strictly true, the accuracy of the doctrine being in no way dependent on the accuracy of observation of the result of the experiment.

He therefore regarded experiments on the laws of motion as illustrative experiments, meant to make us familiar with the general aspect of certain phenomena, and not as experiments of research from which the results are to be deduced by careful measurement and calculation.

Thus experiments on the fall of bodies may be regarded as experiments of research into the laws of gravity. We find by careful measurements of times and distances that the intensity of the force of gravity is the same whatever be the motion of the body on which it acts. We also ascertain the direction and magnitude of this force on different bodies and in different places. All this can only be done by careful measurement, and the results are affected by all the errors of observation to which we are liable.

The same experiments may be also taken as illustrations of the laws of motion. The performance of the experiments tends to make us familiar with these laws, and to impress them on our minds. But the laws of motion cannot be proved to be accurate by a comparison of the observations which we make, for it is only by taking the laws for granted that we have any basis for our calculations. We may ascertain, no doubt, by experiment, that the acceleration of a body acted on by gravity is the same whatever be the motion of that body, but this does not prove that a constant force produces a constant acceleration, but only that gravity is a force, the intensity of which does not depend on the velocity of the body on which it acts.

The truth of Dr. Whewell's principle is curiously illustrated by a case in which he persistently contradicted it. In a paper communicated to the Philosophical Society of Cambridge, and reprinted at the end of his "Philosophy of the Inductive Sciences," Dr. Whewell conceived that he had proved, *à priori*, that all matter must be heavy. He was well acquainted with the history of the establishment of the law of gravitation, and knew that it was only by careful experiments and observations that Newton ascertained that the effect of gravitation on two equal masses is the same whatever be the chemical nature of the bodies, but in spite of this he maintained that it is contrary not only to observation but to reason, that any body should be repelled instead of attracted by another, whereas it is a matter of daily experience, that any two bodies when they are brought near enough, repel each other.

The fact seems to be that, finding the word weight employed in ordinary language to denote the quantity of matter in a body, though in scientific language it denotes the tendency of that body to move downwards, and at the same time supposing that the word mass in its scientific sense was not yet sufficiently established to be used without danger in ordinary language, Dr. Whewell endeavoured to make the word weight carry the meaning of the word mass. Thus he tells us that "the weight of the whole compound must be equal to the weights of the separate elements."

On this Mr. Todhunter very properly observes :—

"Of course there is no practical uncertainty as to this principle ; but Dr. Whewell seems to allow his readers to imagine that it is of the same nature as the axiom that 'two straight lines cannot inclose a space.' There is, however, a wide difference between them, depending on a fact which Dr. Whewell has himself recognised in another place (see vol. i., p. 224). The truth is, that *strictly* speaking the weight of the whole compound is not equal to the weight of the separate elements ; for the weight depends upon the position of the compound particles, and in general by altering the position of the particles, the resultant effect which we call weight is altered, though it may be to an inappreciable extent."

It is evident that what Dr. Whewell should have said was : "The mass of the whole compound must be equal to the sum of the masses of the separate elements." This statement all would admit to be strictly true, and yet not a single experiment has ever been made in order to verify it. All chemical measurements are made by comparing the weights of bodies, and not by comparing the forces required to produce given changes of motion in the bodies ; and as we have just been reminded by Mr. Todhunter, the method of comparing quantities of matter by weighing them is not strictly correct.

Thus, then, we are led by experiments which are not only liable to error, but which are to a certain extent erroneous in principle, to a statement which is universally

acknowledged to be strictly true. Our conviction of its truth must therefore rest on some deeper foundation than the experiments which suggested it to our minds. The belief in and the search for such foundations is, I think, the most characteristic feature of all Dr. Whewell's work.

J. CLERK MAXWELL

GOULD'S BIRDS OF NEW GUINEA

The Birds of New Guinea and the Adjacent Papuan Islands, including any new Species that may be Discovered in Australia. By John Gould, F.R.S., &c. Parts I., II., and III. (London: Published by the Author, 1875-76.)

NOT long ago we had the pleasure of recording in these columns the completion of one of Mr. Gould's great series of illustrated works on ornithology. We have now to notice the commencement of another work belonging to the same category, of not less importance, on the origin of which we propose to say a few words. The "Birds of Australia" must be known to most of our scientific readers as one of the most important ornithological works ever produced in this or any other country. Defects it has, no doubt—nothing is perfect in this world—but, whereas before its existence the birds of that great continent were almost unknown to naturalists, the termination of Mr. Gould's labours left us with such a history of the feathered inhabitants of this portion of the globe as hardly any other country at that time possessed. Some years after the completion of his "Birds of Australia," Mr. Gould issued the first number of a supplement to the same work, undertaken for the purpose of illustrating the new species discovered by his various agents and correspondents, as new portions of Australian territory were explored. This was completed in 1869, and gave us an account of 81 species, in addition to 600 already included in the original "Birds of Australia." The work of which the two first numbers are now before us—though a different title is given to it—is, in fact, a second supplement to the "Birds of Australia." New Guinea, as is now well understood by naturalists, in spite of a certain amount of idiosyncrasy, belongs essentially to the same fauna as Australia. Long ago it was known that many peculiarities are common to the animal and vegetable products of these two countries. Since Northern Australia has been explored, and further investigation made of the rich fauna of New Guinea, the many points of contact between the natural productions of these two lands have been greatly augmented, and there can be little question that we have in New Guinea an exaggerated reproduction of many of the chief peculiarities of the Australian type. Looking to the great interest that is now more than ever attaching itself to the products of New Guinea, Mr. Gould has very naturally determined to combine his illustrations of the many wonderful birds of that country with the new additions that he still continues to receive from Australia, and this is, in fact, the object of the present work.

The great feature in the ornithology of New Guinea is, as is well known, the Paradise-Birds, which are mostly confined to that country and the adjoining islands, though some of the members extend far into North Eastern Australia. The splendid metallic colouring of these birds and the ornamental tufts and plumes that adorn the adult males, afford welcome subjects to the artist's pencil, and are naturally objects on which Mr. Gould is desirous of showing his habitual skill. We have not, therefore, to turn over many leaves of his first number, before we come across representations of two of the finest members of this group, namely the Six-plumed Paradise Bird, known to naturalists since the days of Linnæus, and D'Albertis' Paradise Bird, one of the most recent additions to this remarkable group. In the second number Mr. Gould gives us figures of the three species of *Diphyllodes*, another remarkable member of the same family. Some of the splendid parrots of New Guinea are likewise depicted.

In the third part of his work, which has only been issued within these last few days, further illustrations of the magnificent group of Paradise-Birds are given. The singular species of *Diphyllodes*, so remarkable for its bare head, which the late Prince Charles Bonaparte, in his democratic ardour, dedicated to the Republic, is among the most striking forms yet discovered even in this wonderful group, and both sexes are admirably figured in the present number. Although originally described from a single imperfect specimen, this striking bird has recently been discovered by Dr. Bernstein living in the islands of Waigion and Botanta, and no less than ten specimens obtained by this zealous but unfortunate explorer ornament the gallery of the Leyden Museum. The King Bird of Paradise (*Cicinnurus regius*) is another species selected by Mr. Gould for illustration in the present number. Although known to us since the last century, it is only of late years that perfect specimens have reached the collections of Europe. Our countryman, Mr. Wallace, was one of the first naturalists to observe it in its native forests, and his eloquent account of the specimens obtained by him in Aru will be known to many of our readers. Still more recently, the naturalists in the employ of the Leyden Museum and the Italian explorers D'Albertis and Beccari have sent to Europe a large number of specimens of it. Five charming parrots of the most brilliant and strongly contrasted colours, several of which are hitherto unfigured, are likewise depicted in Mr. Gould's third number.

The part terminates with figures of two recent additions to the Avifauna of Australia. Of these the two named *Sternula placens* is perhaps rather a doubtful species as regards its novelty to science, though doubtless new to the Australian list. The second *Glyciphila subfasciata* is one of Mr. E. P. Ramsay's interesting discoveries in Northern Queensland, and is one of the smallest and most plainly coloured of the great and characteristic of the Australian family of Honey-eaters.

In concluding our notice of this important work, we may venture to say that those who are acquainted with the author's failing health, cannot but admire the spirit which he has displayed in commencing it, while every one will, we are sure, heartily join with us in wishing him complete recovery and a successful accomplishment of his arduous task. When one of our Italian friends has recently described fifty-two new species of Papuan birds in a single memoir, even Mr. Gould's well-known energy will have to exert itself considerably in order to keep up with what is going on.